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DECLINE IN EGG QUALITY DURING THE MARKETING PROCESS

by

H. E. Erdman and George B. Alcorn

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DECLINE IN EGG QUALITY DURING THE MARKETING PROCESS

by

H. E. Erdman 1/ and George B. Alcorn 2/

In the spring of 1937 an attempt was made to determine the quality of given lots of eggs at each of a series of marketing stages as eggs moved from farms in the vicinity of Los Angeles through given trade channels. It was quickly realized that with the small number of eggs that could be examined repeatedly, there were so many incidental variations that accurate comparisons between different methods of selling were not possible. It seemed that one of the more significant variables was the length of time eggs were in process of movement between producer and consumer. When it became possible to repeat the study in midsummer, it was, therefore, decided to ascertain quality changes in larger lots under two sets of conditions as found in the movement of San Fernando Valley eggs into the Los Angeles wholesale market. No attempt was made to trace quality changes in the various retail outlets. Neither was it feasible to cover a variety of climatic conditions.

Procedure

In order to avoid or minimize quality differences arising out of variations in flock management, environment, age of birds, hereditary differences and numerous other factors, it was decided to start the project upon one ranch where a large supply of eggs might be obtained from birds of the same age, kept under identical conditions, and with somewhat the same hereditary background.

Three lots of eggs were carried throughout the experiment. Lot 1 consisted of 720 eggs (two cases). One half was placed in a burlap cooler 3/ in galvanized buckets as they came from the nests, the other half placed on the feed room floor. All eggs were candled and the results recorded during the late afternoon of the day on which they were laid. Immediately after candling, a 3~~6~~-dozen sample each of the cooler and non-cooler portions was broken out and scored. The cooler case was then replaced in the burlap water cooler, and the other case was left on the feed room floor. The candling and breakout process was repeated on the third day, after which the eggs were shipped to a wholesale establishment in Los Angeles where the cooler case was placed in a merchandising refrigerator which was kept at about 48° F. The other case was left on the warehouse floor outside of the cooler. The candling and breakout process was repeated in the warehouse on the fifth, eighth, tenth, and twelfth days.

Lot 2, consisting of 720 eggs from the same flock, was started two days after Lot 1 and was handled in the same way as Lot 1 except that gradings and recordings were made on the first, third, sixth, eighth, tenth, and thirteenth days.

Lot 3, which was started nine days after Lot 1, consisted of 360 eggs

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3/ For a description see Benjamin, E. W., and H. C. Pierce. Marketing poultry products. New York, 1937. p. 196.

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from the same flock. One half was again kept under the cooler conditions and the other half under the non-cooler conditions of Lots 1 and 2. Lot 3 was not candled but was scored for breakouts on the first, second, third, fifth, and seventh days.

Temperature and humidity were recorded by Friez recording machines in the farm feed room, in the farm cooler, in the warehouse, and in the warehouse cooler. The decision to keep the eggs on the wholesaler's floor rather than to follow them through the retail channels was made because of the difficulty of controlling conditions and avoiding disturbance of the samples in retail stores. Furthermore, it was assumed that conditions on the wholesale floor would not greatly differ from those in most of the better retail establishments. This was probably true so far as temperature is concerned, as indicated by the temperature range of the Los Angeles Weather Bureau and that for the wholesaler's floor. (See fig. 4.) The relative humidity would, however, doubtless be lower in the retail stores than on the wholesaler's floor because the latter uses a sprinkler system to maintain humidity. (See fig. 5.)

How Quality was Measured

The selection of suitable measures of egg quality is difficult. The candling method, which is used for commercial purposes and which is the best and only feasible method for that purpose, is, after all, only a rough method of judging the interior quality of the egg. However, because of its commercial significance it was felt that the candling method should be used in conjunction with whatever other method might be employed. In order to make it usable, some rather definite measurements were necessary in order that rather fine comparisons might be made and that variations arising out of the human element in grading might be minimized.

The first candling factor considered was depth of air cell. A measure card placed over the end of the egg when held before the candle made definite measurements of the depth of the air cell possible. These were recorded for each individual egg.

The second candling factor considered was yolk shadow. It is generally assumed that the darker the shadow the yolk casts before the candle, the poorer the quality of the egg. A color scale [4] made up of gelatins which had twelve different shades was used to classify the intensities of the yolk shadows. The darkest spot of the yolk shadow was compared with the scale held just below it. These yolk shadow scores were recorded for each individual egg.

While eggs are sold on a candling basis, the consumer judges quality wholly from the appearance of the egg when broken out. In order to note changes in quality as they appear to the consumer the Van Wagenen [5] Breakout Scores were used as an index of quality for the broken-out egg. The Van Wagenen scores are based upon the consistency, height, and formation of the firm albumenn when an individual egg is broken out and allowed to spread out upon a flat surface. Since the use of the breakout method made future examinations of the same eggs impossible, it was necessary to start with a sample large enough to

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[4] The Pacific Egg Producers' "Shadow Scale No. 2" was the one used.

[5] Van Wagenen, A., and H. S. Wilgus, Jr. The determination and importance of the condition of the firm albumen in studies of egg-white quality. Journal of Agricultural Research. 51(12). 1935.

last throughout the period. The number of eggs broken out for each lot at each time the eggs were candled was three dozen for the cooler and three dozen for the non-cooler portion of the lot.

Results Obtained

Figure 1 shows the curves of the average breakout scores of the three lots. Except for the first day, 108 eggs are contained in each average up through the seventh day, and seventy-two eggs in each average from the seventh to the twelfth day. The slight upturns of the cooler lot curve after the fifth day arise out of the human element in grading or the changing sample. It will be remembered that a different lot of thirty-six eggs was candled and broken out at each breakout point. The curve of deterioration as portrayed by the breakout score showed a general levelling off for the cooler lot when kept at 48° F. in contrast to the non-cooler lot which continued to decline in breakout quality score.

Figures 2 and 3 show the average yolk shadow and depth of air cell respectively of the particular eggs that were broken out on the designated days and whose breakout score averages are graphed in figure 1.

When an egg is laid, there is no air cell. The cell forms slowly as the body of the egg contracts in response to a lower temperature. Therefore, in freshly gathered eggs, the air cell, if existing at all, is so small that accurate measurements are almost impossible. Consequently air-cell measurements on the first day were not recorded. The air cell depth as given in figure 2 for the second day is taken from the average of four contemporary lots.

Increase in depth of air cell and breakout score was greatest the first three days with the rate decreasing thereafter. It must be recognized, however, that the volume of the air cell increases faster than does the vertical measurement of its depth. Therefore, even with a constant rate of shrinkage, a levelling off in the curve of the depth of the air cell is to be expected. It is to be noted from figure 2 that for both cooler and non-cooler lots the air cell depth increased more rapidly after the tenth day.

Deterioration of egg quality as measured by the average yolk shadow score (fig. 2) continued throughout the period at a fairly steady rate. The cooler lot, however, had the lower average yolk shadow score which increased at a slower rate than did the non-cooler lot.

It should perhaps be emphasized that the shapes of the curves depend upon the kinds of measurements used for each of the qualities and upon the scales used in laying out the charts. Hence the mere shape of a curve proves nothing.

Also it should be remembered that the numerical values we have given the various qualities are arbitrary -- the consumer did not make them. They do indicate that the quality indicators ordinarily used by the trade show a rather steady decline in quality during the period of study.

Figures 4 and 5 show respectively the average daily range in temperature and relative humidity in the places where the eggs were kept. The daily maximum and minimum readings are given in tables 4 and 5.

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Results Obtained

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Relation between Age of Eggs and Average Breakout Score of

Cooler and Non-Cooler Lots

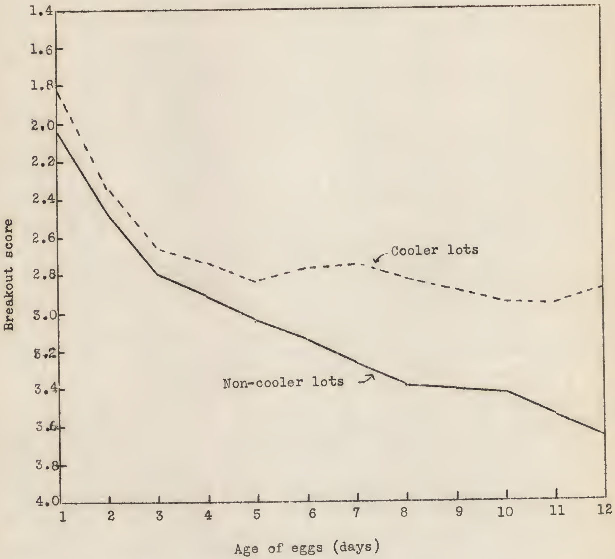

Fig. 1. -- The cooler lot showed a better score than the non-cooler lot throughout the period. Both cooler and non-cooler lots showed the greatest deterioration during the first three days with the rate of decline decreasing thereafter. Eggs were between six and twelve hours old when scored on the first day which may account for lot differences of the first day.

Data for the above curves given in table 1.

Relation between Age of Eggs and Average Yolk Shadow Score for

Cooler and Non-Cooler Lots

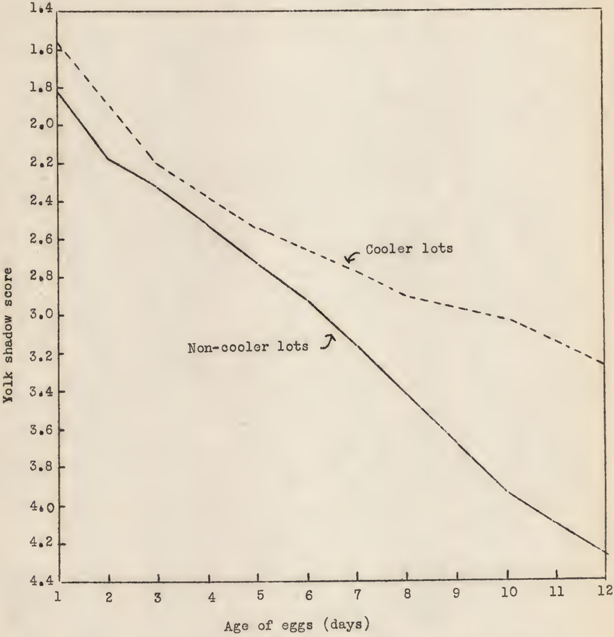

Fig. 2. -- The non-cooler lot showed a rather steady increase in intensity of yolk shadow. The cooler lot throughout the period showed a less intense yolk shadow which increased in intensity less than the non-cooler lot.

Data for the above curves, given in table 2, are taken from the curves of four individual lots, two cooler and two non-cooler.

Relation between Age of Eggs and Average Depth of Air Cell for Cooler and Non-Cooler Lots

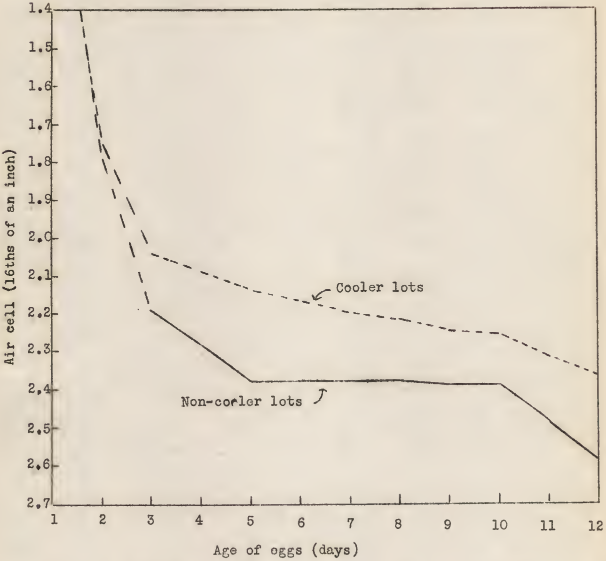

Fig. 3. -- Greatest increase in depth of air cell occurred during the first three days, with the increase thereafter rather slow. Dashed portions of the curves, that is, the first three days, are approximations as determined from four other contemporary lots.

Data for the above curves, given in table 3, were taken from the curves of four individual lots, two cooler and two non-cooler.

The temperature range in Los Angeles as given by the United States Department of Agriculture Weather Bureau was both narrower and lower than that on the farm in the San Fernando Valley.

The farm cooler was effective in lowering the average of the maximum daily temperature 13.77° below that of the feed room. It also was able to raise the relative humidity appreciably and narrow its range over that of the feed room. The farm cooler in the San Fernando Valley for the period did not, however, decrease either average daily maximum or minimum temperatures below that reported by the United States Department of Agriculture Weather Bureau for Los Angeles.

The average daily range in temperature in the warehouse in Los Angeles was 10.82° less than the average range for Los Angeles as reported by the Weather Bureau. It should be stated, however, that humidifers were used in the warehouse.

Humidity as shown in figure 5 varied most widely under the uncontrolled conditions of the feed room. Partial control of humidity narrowed its range in the warehouse and farm cooler. Almost absolute control in the warehouse cooler resulted in virtually constant humidity conditions.

Inasmuch as the daily maximum and minimum temperatures and humidity readings do not vary greatly from their averages for the period, it seems reasonable to assume that deterioration as measured by the three factors, breakout appearance, yolk shadow, and depth of air cell shown in figures 1, 2, and 3 is the result of changes taking place in the interior of an egg during approximately the period of time ordinarily taken by the marketing process to move eggs from producer to consumer. The eggs in the non-cooler lot were subjected to an average maximum temperature for the first three days of over 92° F. with the relative humidity ranging between an average of 32.15° and 83.92°. After the third day the average maximum temperature was 75.44° F. with humidity ranging between 66.80° and 74.50° F. The cooler lots were subjected to an average maximum temperature on the farm of 78.50° F. with relative humidity between 60° and 88.46°, and in the warehouse cooler the average temperature was 48° F. with the humidity range between 57.90° and 61.00°, average maxima and minima.

It may be a matter of surprise that the cooler and non-cooler lots showed somewhat similar declines in the farm cooler. The only explanation offered is the fact that the eggs were placed in the cooler in galvanized iron buckets. An experiment at the Missouri Experiment Station showed that eggs cooled very much more slowly in such buckets than in wire buckets or trays.6/

Relation of Marketing Channels to Age of Eggs

The ordinary range in the ages of eggs at the various marketing stages as they pass from producer to consumer is presented in a schematic form on page 11. This represents the more favorable conditions with the movement through the marketing channels unobstructed by carelessness, speculative withholding, or temporary market gluts.

6/ Funk, E. M. The cooling of eggs. Missouri Agr. Exp. Sta. Bul. 350. 1935.

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Average Range in Daily Temperatures at Five Places during the Period

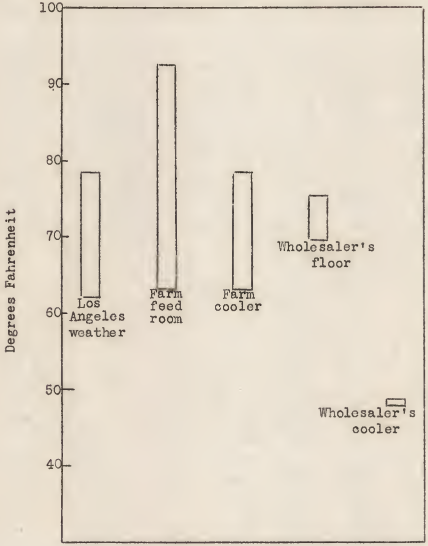

Fig. 4 -- The temperature range in Los Angeles was lower than that in the San Fernando Valley where the farm was located. The farm cooler was effective in lowering the average of the maximum daily temperature 13.77° below that of the feed room. The average range in temperature in the warehouse in Los Angeles was 10.82° less than the average range as reported by the United States Department of Agriculture Weather Bureau for Los Angeles.

Data for figure 4 are presented in table 4.

Average Range in Daily Humidity Readings at Four Places Where Eggs Were Kept During the Period

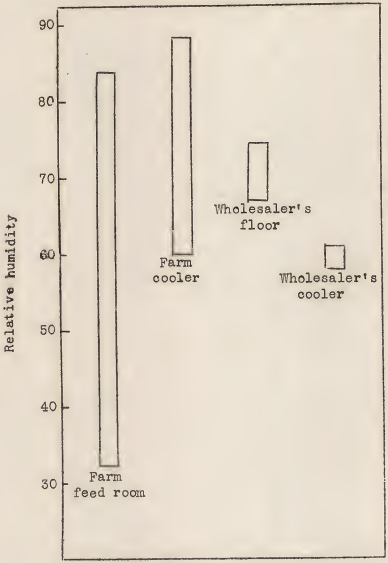

Fig. 5 -- As to be expected the feed room showed the greatest range in relative humidity. The farm cooler increased the humidity appreciably over that existing in the feed room. Humidifiers were used on the floor of the warehouse which accounts for the narrow range in humidity there.

Data for figure 5 are presented in table 5.

It was assumed that the maximum age of eggs leaving the farms was four days. There may be some variation in this, however, as unfilled cases are sometimes left to be filled and picked up at the next pick-up. Also in periods of rapidly advancing prices, some producers withhold a portion of their eggs for a following pick-up when prices are likely to be higher.

Eggs should move from the producers to the consumer as rapidly as possible. However, the market is sometimes glutted and stocks may pile up on dealers' floors for short periods. In anticipation of seasonal price rises, eggs may be "short held" up to as much as thirty days. There is some trading between distributors as one finds himself short and another long on certain qualities. Such trading may cause further delays of one to several days.

The length of time eggs may remain in the retail store has been the subject of two surveys, one conducted in 1934 [7] and one by the authors conducted concurrently with the quality study discussed above. Both surveys showed that while most of the eggs were in the store five days or less, some lots were in the stores up to two weeks and in one case even up to three weeks. The retailers, like the producers and distributors, hope to profit by price increases and are likely to overstock during periods of rising prices.

Summary

The study consisted in candling and then breaking out, at intervals during a two-week period, of eggs kept under two sets of conditions. One set of conditions represented those of summer in a San Fernando Valley feed room followed by a trip to Los Angeles where the eggs were kept on the warehouse floor during the length of time it commonly takes for eggs to move to the consumer.

The second set of conditions differed only by the fact that the eggs were kept in a burlap cooler on the farm and in a merchandising cooler at the warehouse. The eggs showed a fairly steady decline in quality as indicated by the two indicators commonly used by the trade, namely yolk shadow and air cell. The same general decline was found upon breaking the eggs.

A study of eggs in retail stores disclosed a wide range of quality. This was doubtless a result of differences in age of eggs, temperature or other keeping conditions, and perhaps of variations traceable to hereditary conditions.

The study suggests that two ways of improving the quality of eggs reaching consumers may be (1) decreasing the length of time they are on the way from the producer and (2) improving the conditions under which they are kept during the marketing process.

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[7] Voorhies, E. C., and J. B. Schneider. Egg statistics relating to the southern counties of California. Giannini Foundation of Agricultural Economics. Mimeographed Report No. 33. 1934. pp. 1-33.

TABLE 1

Ordinary Range in Age of Fresh Eggs in the Marketing Channels Under Reasonably Good Conditions

	Producers		Distributors	Retailers
Usual market channel for near-by eggs	The usual practice is for eggs to be picked up twice a week which alternates between three and four days. Therefore eggs leaving the farm are from 1 to 4 days old. Eggs leave when between 1 and 4 days old.		The distributors perform the candling, grading, storing, and distributing functions. Although there are variations between distributors and even variations in the same plant, the following is given as an example which is believed to be representative: Eggs are between 1 and 4 days old at arrival. Eggs are between 2 and 5 days old when candled. Eggs are between 3 and 6 days old when cartoned. Eggs are between 4 and 7 days old when delivered.	Most retailers are able to get deliveries twice a week and some get four deliveries a week or even daily deliveries, so that eggs should not have to remain long in the retail store. Assuming bi-weekly delivery: Eggs are commonly between 4 and 7 days old at arrival, and between 4 and 11 days old when sold.
Market channel for outlying area	Eggs leave when between 1 and 4 days old.	Feed store, pick-up men, country receiving station Arrive 1st-4th day. Leave 1st-6th day.	Arrive 1st-6th day Candled 2nd-7th day Cartoned 3rd-8th day Delivered 4th-9th day	Arrive 4th-9th day Sold 4th-13th day
Producer to retailer	Eggs leave when between 1 and 4 days old.			Arrive 1st-4th day Sold 1st-8th day

APPENDIX

TABLE 1

Van Wagonen Breakout Score Averages[*] of Six Breakout Lots with Interpolations for Intervening Days

	Day											
	1	2	3	4	5	6	7	8	9	10	11	12
						Non-cooler lots						
Lot 1[†]	1.94[‡]	2.37[§]	2.82	2.98[§]	3.14	3.22[§]	3.30[§]	3.39	3.39[§]	3.40	3.54[§]	3.66
Lot 2[†]	2.32[‡]	2.53[§]	2.74	2.84[§]	2.96[§]	3.06	3.22[§]	3.39	3.43[§]	3.46	3.56[§]	3.68[§]
Lot 3[¶]	1.85	2.58	2.82	2.92[§]	3.02	3.14[§]	3.28					
Non-cooler lots	2.04	2.46	2.79	2.91	3.04	3.14	3.27	3.39	3.41	3.43	3.55	3.67
						Cooler lots						
Lot 1[†]	1.66[‡]	2.12[§]	2.58	2.80[§]	3.07	3.00[§]	2.94[§]	2.79	2.86[§]	2.99	3.01[§]	3.01
Lot 2[†]	2.05[‡]	2.46[§]	2.88	2.79[§]	2.71[§]	2.64	2.72[§]	2.86	2.92[§]	2.93	2.83[§]	2.74[§]
Lot 3[¶]	1.79	2.44	2.50	2.60[§]	2.69	2.66[§]	2.60					
Cooler lots	1.83	2.34	2.66	2.74	2.84	2.77	2.75	2.83	2.89	2.96	2.97	2.89

[*] Thirty-six eggs in each average.

[†] Lots 1 and 2 ran for twelve days.

[‡] Nine eggs in these four averages.

[§] Read from curves; no actual breakout on this day.

[¶] Lot 3 was exhausted in seven days.

TABLE 2

Average* Yolk Shadows of Four Lots With Interpolations for Intervening Days

	Day											
	1	2	3	4	5	6	7	8	9	10	11	12
	Non-cooler eggs											
Lot 1	1.76†	2.16‡	2.36	2.58‡	2.80	3.02‡	3.22‡	3.44	3.72‡	4.00	4.10‡	4.20
Lot 2	1.88†	2.18‡	2.28	2.46‡	2.64‡	2.82	3.10‡	3.40	3.65‡	3.88	4.12‡	4.34‡
Two lots	1.82	2.17	2.32	2.52	2.72	2.92	3.16	3.42	3.68	3.94	4.11	4.27
	Cooler eggs											
Lot 1	1.44†	1.82‡	2.19	2.40‡	2.61	2.72‡	2.82‡	2.92	2.82‡	2.72	3.06‡	3.39
Lot 2	1.67†	1.94‡	2.22	2.34‡	2.46‡	2.59	2.74‡	2.89	3.12‡	3.33	3.24‡	3.16‡
Two lots	1.56	1.88	2.20	2.37	2.54	2.66	2.78	2.91	2.97	3.03	3.15	3.28

* Thirty-six eggs in each average.

† Nine eggs in these four averages.

‡ Interpolations.

TABLE 3

Averages*of Depth of Air Cell, in Sixteenths of an Inch,
of Four Lots with Interpolations for Intervening Days

	Day											
	1	2	3	4	5	6	7	8	9	10	11	12
Non-cooler eggs												
Lot 1			2.24	2.41†	2.58	2.58†	2.57†	2.57	2.55†	2.53	2.59†	2.64
Lot 2			2.15	2.16†	2.17†	2.18	2.18†	2.19	2.22†	2.25	2.40†	2.54†
Two lots			2.19	2.28	2.38	2.38	2.38	2.38	2.39	2.39	2.49	2.59
Cooler eggs												
Lot 1			2.01	2.10†	2.19	2.24†	2.29†	2.33	2.30†	2.24	2.37†	2.49
Lot 2			2.07	2.08†	2.09†	2.10	2.10†	2.10	2.20†	2.28	2.27†	2.26†
Two lots			2.04	2.09	2.14	2.17	2.20	2.22	2.25	2.26	2.32	2.37

* Thirty-six eggs in each average.

† Interpolations.

TABLE 4

Maximum and Minimum Daily Temperatures

Throughout the Period at Five Places

Los Angeles weather		Farm feed room		Farm cooler		Dealer's floor		Dealer's cooler	
Maximum 1	Minimum 2	Maximum 3	Minimum 4	Maximum 5	Minimum 6	Maximum 7	Minimum 8	Maximum 9	Minimum 10
86	62	100	60	80	58	78	70	48	48
80	62	92	64	78	64	76	70	50	50
78	60	96	64	78	63	76	70	48	48
76	60	90	64	80	62	76	70	48	46
76	62	90	64	76	64	74	70	47	46
78	62	89	61	78	64	74	70	47	46
76	62	89	64	76	61	74	70	47	46
76	63	94	60	77	64	75	70	50	49
78	61	92	62	80	60	76	70	51	50
80	62	91	68	79	62		68	51	49
80	65	92	64	80	68				
	64			80	66				
Averages									
78.54	62.08	92.27	63.18	78.50	63.00	75.44	69.80	48.70	47.80

Sources of data:

Cols. 1 and 2: Data from United States Department of Agriculture, Weather Bureau.

Cols. 3 to 10: Temperatures at the farm and warehouse recorded on Friez temperature and humidity recording machines.

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TABLE 5

Maximum and Minimum Daily Relative Humidity Readings at Four Places for the Period

Farm feed room		Farm cooler		Dealer's floor		Dealer's cooler	
Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
75	20	83	60	75	64	65	62
84	32	91	60	72	64	66	65
86	32	92	60	71	66	69	66
86	35	84	58	72	67	63	62
85	30	89	58	70	66	63	62
85	35	90	60	71	63	64	62
86	35	90	60	80	66	64	62
89	32	91	65	84	72	63	48
86	32	84	65	75	70	48	45
82	37	92	57	75	70	45	45
87	35	82	64				
88	35	90	60				
72	28	92	53				
Averages							
83.92	32.15	88.46	60.00	74.50	66.80	61.00	57.90